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## **Evaluation of NASA Explorer Schools: Pilot Study**

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## Table of Contents

<b>Introduction .....</b>	<b>1</b>
NES Pilot.....	2
<b>Methodology .....</b>	<b>3</b>
Research Questions .....	3
Data Sources .....	4
Student Surveys .....	4
Teacher Surveys .....	5
Teacher Interviews .....	6
Teacher Focus Groups .....	6
Web Use Data .....	7
NES Extant Documents and Conversations with Staff.....	7
<b>Findings.....</b>	<b>7</b>
Classroom Materials.....	8
Curriculum Materials.....	8
Virtual Breaking News (VBNs).....	13
Teacher Support.....	15
Electronic Professional Development (ePD).....	15
Social Networking Tool.....	17
Website.....	18
Project Communication with Teachers .....	19
Student Outcomes.....	19
Student Engagement with the NES Materials.....	20
Self-Efficacy.....	20
Interest in STEM .....	20
Interest in STEM Careers .....	21
NASA-Specific Outcomes .....	22
Project Operations .....	23
Teacher Recruitment.....	23
Data Collection during Pilot .....	24
Communication among Partners and Key Stakeholders .....	25
<b>NES Response to Lessons from Pilot .....</b>	<b>25</b>
Curriculum Selection Plan.....	26
Videos for Classroom Use .....	26
VBN.....	26
ePD .....	26
Curriculum Use.....	26
Recruitment .....	26
Alignment to State Standards .....	27
Participant Support .....	27

<b>Conclusions .....</b>	<b>27</b>
Research Questions.....	27
Classroom Materials.....	27
Teacher Support.....	28
Student Outcomes.....	29
Recommendations .....	29
Social Networking.....	29
Timing and Implementation .....	30
State Standards .....	30
Modifications to Materials .....	30
Teacher to Teacher Recruitment .....	31
Wide Range of Developmental Levels.....	31
Specific Considerations for Evaluation .....	32
Tracking Use of Materials .....	32
Measuring Student Engagement.....	32
Investigating the Recognition Component .....	32
<b>Appendix A. Lesson Learned Topics .....</b>	<b>34</b>
<b>Appendix B. Non-Response Bias Tests for Student Surveys.....</b>	<b>36</b>

## Introduction

*“The NASA Explorer Schools project is NASA’s classroom-based gateway for middle school (grades 4-8) and high school (grades 9-12) classrooms providing authentic learning experiences inspired by NASA’s unique missions.”<sup>1</sup>*

Responding to recommendations from the National Research Council committee that reviewed NASA’s elementary and secondary education projects,<sup>2</sup> NASA embarked on a redesign of the NASA Explorer Schools (NES) project in 2008.<sup>3</sup> In its recent report, *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future*, the President’s Council of Advisors on Science and Technology (PCAST) concluded that to improve education in STEM, the country needed to focus both on the preparation and inspiration of students.<sup>4</sup> The NES model aligns with the focus of the PCAST report as the NES project represents a coherent effort by NASA to help prepare students in STEM and inspire them to pursue STEM careers, or at a minimum, become part of a STEM-literate citizenry.

The development of the new NES model involved a working group comprising individuals from NES and the Mission Directorates, staff from NASA’s Office of Education (OE), strategic partners, teacher and administrators, and leading members of the national STEM education community. The redesigned NES model includes four core elements: (1) STEM curriculum support materials; (2) electronic professional development (ePD); (3) virtual NASA news events; and (4) teacher, student, and school recognition opportunities. NES is run by staff from both NASA and implementing partners, which are contractors involved in the implementation of various components of the NES project. In addition, NES involves strategic partners, who are external stakeholders that are collaborating with NES to support the NES model; for example, strategic partners were involved in validating materials and recruiting teacher participants for the pilot.

The new NES model, minus the recognition opportunities, was pilot tested in spring 2010. As part of the pilot activities, NES gathered data from teachers and students to identify ways to improve the project’s performance. The NES project incorporated these lessons into the project for its September 2010

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<sup>1</sup> NASA website <http://www.nasa.gov/offices/education/programs/national/nes2/home/index.html>

<sup>2</sup> National Research Council. (2008). *NASA’s Elementary and Secondary Education Program: Review and Critique*. Committee for the Review and Evaluation of NASA’s Precollege Education Program, Helen R. Quinn, Heidi A. Schweingruber, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences Education. Washington, D.C. The National Academies Press.

<sup>3</sup> Launched in 2003, the original NASA Explorer Schools (NES) project consisted of three-year partnerships between NASA and selected schools. The project focused on whole schools and provided financial investment, professional development, and curricular support designed to provide engaging student STEM educational experiences and sustained professional development, and to enhance family involvement in science education.

<sup>4</sup> President’s Council of Advisors on Science and Technology (2010). *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future*.  
<http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf>

launch. Abt Associates reviewed the data collected during the pilot to succinctly codify lessons learned so that NES staff and other stakeholders can easily reflect on them and reassess at the end of this year's implementation. This report contains a summary of findings from the pilot study that was conducted in spring 2010. We first describe our methodology and findings from our analyses of the pilot data, and then present our conclusions and recommendations.

## NES Pilot

The plans for the NES pilot called for testing eight to ten NASA educational products with approximately 30 teachers and schools across the country. Eight NASA products were selected for inclusion in the pilot, which were used by 57 teachers across 48 schools. Orientation sessions for the NES pilot, which were led by the NES project manager, were conducted using WebEx.

To be considered full implementers of the pilot, teachers were expected to complete a minimum set of project activities: participate in the orientation session, use one content module in their classrooms, use one Virtual Breaking News segment in their classroom, complete one ePD, and return the student pre- and post-surveys. Completion of the pre-program student survey was tracked and used as the basis for inviting teachers to a post-pilot workshop at the Johnson Space Center in Houston, Texas.

To recruit teachers, NES partnered with the Department of Education's Mathematics and Science Partnership program (MSP) in three states (Texas, Louisiana, and Georgia), the International Center for Leadership in Education (ICLE), International Technology and Engineering Educators Association (ITEEA), National Science Teachers Association (NSTA), and NASA Endeavour Science Teacher Program. In addition, some pilot teachers were recruited from among teachers and schools that had participated in the original NES project. Fourteen of the 48 schools were recruited through MSP, and 25 of the 57 teachers had prior experience with NASA.<sup>5</sup>

The NES pilot also included an evaluation component, which was guided by a framework developed by the NES team prior to the pilot's start. NES staff noted that decisions about data collection were constrained by government regulations that prohibit the tracking of individual internet address and the time required for OMB review of data collection procedures. The evaluation framework was organized around the four pilot objectives to: (1) evaluate and assess NES curricula and support materials; (2) test NES information technology (IT) delivery vehicles; (3) assess communication and recruitment needs; and (4) track and evaluate NES workload and operations.<sup>6</sup> At the completion of the pilot project, NES staff developed a lessons learned document focused on 18 topic areas across four categories: project delivery, engagement, evaluation and assessment, and project management. An outline of this document can be found in Appendix A. The lessons learned document drew on data collected during the

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<sup>5</sup> Project documents cite different numbers of participating teachers. These figures were taken from project records reported after the pilot, including personal communications, and NASA Explorer Schools. *NASA Explorer Schools Briefing* Presentation at NASA Headquarters, Washington DC. November 10, 2010.

<sup>6</sup> Booz Allen Hamilton *NASA Explorer Schools: Evaluating the NES Project*. Presentation at NASA Headquarters, Washington DC. January 13, 2010.

project in addition to staff experiences, observations, and conversations during the pilot period. For each topic area, the document contained specific lessons, implications for the project, and proposed corrective actions.

## Methodology

Abt conducted a review and analysis of data collected during the pilot implementation of NES in order to answer the research questions drawn from the NES pilot evaluation framework. The purpose of this review was not to duplicate the lessons learned document described above, which relied in part on observations and communications that were not documented for our review, but instead to conduct an independent evaluation of the available data and to document the findings.

Abt examined the data collected during the pilot period and supplemented it with information contained in the project's extant materials and conversations with NES staff. In some cases, we analyzed raw data, but in others only summaries of the data were available for our review. Data collected during the pilot included responses from student surveys, teacher surveys, teacher interviews, teacher focus groups, and web analytics or web use data; the individual data sources are described in greater detail below.

## Research Questions

Our review of the data was guided by the pilot evaluation framework developed by the NES team. We structured our analysis to answer the following research questions related to classroom materials, teacher support, student outcomes, and project operations.

### Classroom Materials

- Were the materials selected from among highly-rated NASA educational products?
- Were the NES materials appropriate for the targeted student audiences?

### Teacher Support

- Were teachers able to implement the NES materials with the support provided?
- Were specific forms of support preferred by teachers?
- Are communities of practice being established around NES?
- Did teachers encounter issues in using the NES materials? If so, did NES address these issues?

### Student Outcomes

- Were the NES materials engaging for students?
- Did students express increased interest in STEM topics and careers after participating in NES?

### Project Operations

- What strategies were most effective for recruiting pilot participants?
- Were key stakeholders kept informed and engaged in the NES pilot?

- Were the processes in place sufficient for implementation?
- Was data gathering sufficient for the various information needs of the project?

## Data Sources

The Abt team conducted analyses of the data that were available and reviewed extant project documents. In addition, Abt staff held conversations with NES staff to clarify questions and collect additional information. For much of the data collected during the pilot period, we relied on summary documents because the original data were not available. The specific data sources included: (1) datasets containing responses from the student pre- and post-NES surveys, including a school code for each observation; (2) datasets containing responses from the teacher post event surveys on each specific project component; (3) summary notes from teacher interviews taken by the interviewers; (4) a summary report from teacher focus groups; and (5) web analytics data.

### Student Surveys

Data collected from students in the pilot followed a pre-post program design. Data were collected via a pair of Scantron surveys that were first distributed to teachers who planned to use NES materials in their classrooms. This survey asked students about their current interest in NASA and STEM disciplines as well as knowledge of and future career interests in these fields. The survey consisted of 15 statements for students to rate their level of agreement on a 5-point scale of strongly agree to strongly disagree with statements like “I am interested in NASA”, “I am good at science”, “I am interested in careers in Technology”. An additional question presented students with a list of 20 NASA-and STEM-related activities and asked them to mark those which they would be interested in pursuing. At the end of the semester, teachers were sent follow-up surveys to distribute to these same classes.

The survey datasets do not contain teacher, classroom or student-level identifiers. Therefore there was no way to exclude data of specific students who completed a pre- survey but not a post- survey. However, there were school-level identifiers associated with the data. There was high attrition in survey responses between the pre and post time points. Student surveys were received from all 48 schools prior to the NES pilot implementation (pre-program survey), but from only 37 schools after the NES pilot implementation (post-program survey). Thus, while data were collected from over 3,115 students in 48 schools at the initial time period, the follow-up data collection included responses from only 1,685 students in 37 schools.

To conduct pre-post analyses that investigated change in student outcomes, data from the 11 schools that completed initial surveys but not follow-up surveys (763 data points) were removed prior to analysis. Potentially important differences exist between the schools that completed the follow-up surveys and those that did not, when comparing the initial survey responses from students. Appendix B presents the chi-square analyses that investigate the differences between these groups at baseline.

To investigate whether there was a change in student outcomes after NES experiences, chi-square analyses were conducted on questions 1 through 15 of the student survey that asked students to rate

their agreement with specific statements. For question 16, where students selected the NASA activities they would be interested in pursuing, the total number of activities each student endorsed was calculated and the average number of activities selected on pre-program surveys was compared to the average number selected on post-program surveys.

A potential limitation of the surveys mentioned by NES staff was the reliability of survey responses. Upon visual inspection of the Scantrons it appeared to NES staff that some students filled in answers randomly.<sup>7</sup> In addition, sometimes multiple questions were unanswered or several answers were selected for questions that require only one choice. To correct for this, responses where respondents inappropriately selected multiple answers or selected conflicting answers were removed from the database prior to analysis.

### Teacher Surveys

Data on teachers' experiences with the specific components of NES were gathered through surveys that teachers were encouraged to complete after using curriculum modules, participating in electronic professional development and after viewing a Virtual Breaking News event. Surveys were available on the virtual campus on corresponding webpages, i.e. curriculum module surveys were posted on the curricular content portion of the webpage. Teachers were encouraged to complete surveys for all activities in which they participated.

Teachers were asked to submit surveys that gathered information about specific components of NES; the number of respondents across the activities and for specific modules varied greatly. For ePD, a total of 59 surveys were submitted, and the number of respondents for specific modules ranged from 1 to 15. For VBN modules, there were a total of 40 surveys submitted, and the number for specific events ranged from 1 to 8 respondents. For the curriculum modules, there were a total of 20 surveys submitted, and the number of respondents to the modules ranged from 1 to 4. Although survey completion was not tracked at the individual teacher level, comparing the number of surveys for each component with the number of teachers in the pilot reveals that not all teachers completed surveys for some components (e.g. modules and VBN) and multiple surveys might have been received from individual teachers (e.g. ePD).

The variation in number of surveys completed for the activities—ePD (N=59), VBN (N=40), and curriculum modules (N=20)—may be related to the proximity of the activity to the virtual campus. For example, all ePD was conducted through the website. The link to the ePD survey was on the same webpage as the ePD. After completing the ePD, they saw this visual reminder of the survey and could easily navigate to it. However, to complete a survey on a curriculum module, no link existed and teachers would have to remember that they should take a survey, log into the virtual campus, navigate to the curriculum webpage and then complete the survey.

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<sup>7</sup> Personal communication with NES staff.

To better understand teacher's reactions to NES content across modules, descriptive statistics are presented for each NES component (i.e., ePD, VBN, curriculum module), but data within each NES component were combined across topics.

### **Teacher Interviews**

Forty-four of the 57 pilot teachers were interviewed by phone by NES staff from Booz Allen Hamilton in late May to early June 2010. Of these teachers, 16 were classified at the high school and 28 at the middle school levels; because NES has defined middle school as fourth through eighth grades, some of these middle school teachers were located at elementary schools. Teachers were asked about their use of NES content modules, ePD, classroom media, and the NES web interface. All eight of the pilot modules were represented in the set of teachers that were interviewed.

Data from the interviews consisted of interviewer notes; transcripts were not available. We coded and summarized findings from these notes and used them to examine key components of the pilot NES program.

### **Teacher Focus Groups**

Paragon-TEC and Phillips & Company conducted a series of focus groups with 28 teachers (20 middle school and 8 high school) to review the NES pilot project and offer suggestions for future development and modifications as the project moved forward. The focus groups were conducted during the workshop that was held at held July 7-9, 2010 at Johnson Space Center in Houston, Texas. Participants were all teachers who had returned the post-NES student surveys. In this way, eligibility for the workshop served as an incentive for teachers to return student surveys.

A summary report of the workshop was available for review. The workshop involved a whole group discussion of what would eventually become NES's recognition program and the criteria for that program. It also included separate middle school and high school teacher discussions of how NES products aligned with education goals as well as how NES content integrated into their current curriculum. In addition, there were seven smaller focus groups that discussed the NES products, including the VBN, Virtual Campus, ePD as well as NASA staff and their support.

These focus group discussions produced a wealth of informative qualitative data from which Paragon-TEC created a final report of the focus group's commentary and findings. The Abt Associates team had access to the Paragon-TEC report, but not the raw data from the focus groups. We used this report to examine key components of the pilot NES program, and have summarized and included findings from the focus groups based on the final report. In addition, direct quotes that were illustrative were taken from the report. In choosing quotes we sought to represent the distribution of participant opinions described in the final report.

Because focus group participants included only teachers who returned post-program student surveys, the sample of teachers may be skewed towards the most motivated teachers. We found significant

overlap between teachers who were members of the focus groups and those that were interviewed: 27 of the 28 focus group participants were also interviewed earlier in the pilot.

### Web Use Data

The NASA Education Technology Services (NETS) team collected portal analytics data on a weekly basis to track web portal usage. NES provided Abt with the web analytic data summarizing the access and downloads of the project components. NES staff noted that due to government regulations, they were not able to track use of the website by individual IP addresses.

### NES Extant Documents and Conversations with Staff

NES made project documents available for review. However, because much of the information was gathered informally through staff interactions and first hand knowledge and could not be verified by Abt staff, these documents served as supplemental sources, instead of primary sources of data.

The NES pilot was implemented by staff from within NASA along with contractor staff. We identified specific questions that were not answered in the data available to us and held conversations with NES staff to gather information. In addition, staff helped to clarify questions that arose as Abt reviewed the available data.

## Findings

We limit the findings in this report to areas where documented data was available for review. The pilot data sources contain information about the quality and appropriateness of the NES classroom materials, the appropriateness of support provided to teachers by NES, outcomes related to students' experiences with NES, and project operations. Overall, the NES curriculum materials were well-received by teachers, although the VBNs were viewed less enthusiastically. Generally, teachers were positive about the support they received from NES and felt it prepared them to implement the NES components in their classrooms. Student outcomes of interest to NES showed mixed results, and not specifically tied to their NES experiences. NES made great strides in putting in place successful project operations during the pilot and gathering data to facilitate program modification and full implementation. Specific findings related to these areas are described below.

## Classroom Materials

NES materials for use in classrooms consisted of curriculum materials and VBNs.

### Curriculum Materials

#### *Selection Process*

Although there were limitations imposed by the tight timeline of the pilot, products for the NES pilot were selected via a systematic review process of NASA educational products, which resulted in the selection of eight curriculum modules (four high school and four middle school) for use in the pilot program.

NES identified more than 300 educational materials that have been developed by NASA's Mission Directorates since 2005. These products were filtered to exclude those that did not contain educational activities, and to include only those that aligned with selected specific National Science Education Standards for middle and high schools. NES leadership narrowed the resulting 49 curriculum modules to 31 products—15 middle school and 16 high school products.

Forty-seven experts and practitioners in the field were recruited from partner organizations—International Center for Leadership in Education (ICLE), International Technology and Engineering Educators Association (ITEEA), and National Science Teachers Association (NSTA) — to review the selected 31 curriculum modules. Reviewers rated each module on six dimensions identified in the evaluation rubric: classroom relevance, cross-cutting STEM applicability, analytic rigor, ease of use and curriculum flexibility, anticipated student engagement, and teacher appeal. Each product was reviewed by at least three reviewers.

Ratings were compiled to identify top modules for each age group. NES staff identified content gaps among the top eight products selected by ratings alone, and reviewer comments on specific content modules identified possible issues that were considered when selecting the final set. Overall the curriculum reviewers had highly positive reviews of the modules. For example, one curriculum reviewer's notes stated, "The modules [were] impressive. The modules offer comprehensive, detailed instructions for experiments for both student and teacher. In and of themselves, they are complete in that they offer experimental design, well-explained procedures, data sheets, questions, charts and graphs, etc. This may be the best feature of the product, in that the teacher can use the modules as an off-the-shelf tool."<sup>8</sup> However, comments specific to some of the selected products suggested that additional review and/or consideration should be given to the materials included in NES. For example, one reviewer noted, "Many of the design challenges do not intellectually challenge and are not based

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<sup>8</sup> [Mission Directorate Briefing] NASA Explorer Schools. *NASA Explorer Schools: Mission Directorate Pilot Project Briefing*. Presentation at NASA Headquarters January 20, 2010, p. 18.

around processes of scientific inquiry and/or engineering design.”<sup>9</sup> Comments on another content module, “the online nature of the activities presents several problems...”<sup>10</sup>

NES substituted high-ranking modules to ensure a diversity of topics for the pilot and appropriateness of delivery.<sup>11</sup> The final eight pilot products selected for the pilot were: middle school—*Earth Climate Course*, *Lunar Nautics*, *Engineering Design Challenge*, and *Smart Skies*; and high school — *My NASA Data-Solar Cell Energy*, *Rocket Guide*, *Black Hole Math*, and *Cooling with Sunshades*.<sup>12</sup> Exhibit 1 displays the ratings of the reviewed modules for middle and high school, with the selected products shaded.

**Exhibit 1: Top-rated Modules for Middle Schools and High School**

Middle School	Rating
Earth Climate Course	56.99
Lunar Nautics	53.55
Engineering Design Challenge – Lunar Planet Growth	52.29
Exploring the Moon - Educator Guide	49.88
WLMR Challenge	49.67
Rockets Guide	48.27
Smart Skies	48.26
Meteorology - An Educator Resource	47.67
Saturn Educators Guide	46.69
MND - Using Atmospheric Data	45.67
NASA Connect - Path of Totality	44.89
NASA Connect - Venus Tracking	44.89
Field Trip to the Moon	44.88
Space Weather Action Center	44.49
Mars Student Imaging Project	28.61
High School	Rating
MY NASA DATA (MND) - March of the Polar Bears	54.26
Rockets Guide	53.41
MND - Scientist Tracking	52.05
MND - Solar Cell Energy	52.04
Black Hole Math	50.38
Exploring the Moon - Educator Guide	49.27
Ocean Motion Website	48.01
Cooling with Sunshades	47.80
Earth Climate Course	47.26
Smart Skies	46.92
Engineering Design Challenge	46.79
Foil Sim	45.92
Meteorology - An Educator Resource	42.16
Flight Testing Newton's Laws	39.98
Beginners Guide to Aeronautics	37.05
Mars Student Imaging Project	35.89

<sup>9</sup> Mission Directorate Briefing, p. 20.

<sup>10</sup> Mission Directorate Briefing, p 20.

<sup>11</sup> Personal communication with NES staff on November 9, 2010.

<sup>12</sup> NASA Explorer Schools. *NASA Explorer Schools: Mission Directorate Pilot Project Briefing*. Presentation at NASA Headquarters January 20, 2010.

### Modules Implemented

Data from the interviews indicated that each module was used by at least one of the responding teachers (Exhibit 2), including some who used multiple modules.

**Exhibit 2: Use of Modules among Middle School and High School Teachers**

Middle School	Number
Lunar Nautics	10
Earth Climate Course	9
Engineering Design Challenge – Lunar Planet Growth	5
Smart Skies	5
High School	
Rockets Guide	9
Cooling with Sunshades	4
Black Hole Math	4
My NASA Data - Solar Cell Energy	1

The web analytics tracked the number of views on each of the materials and the corresponding support page for each content module (Exhibit 3). These numbers provide a relative indicator of the page views to each content module, and reveals that the units that were most represented in the interviews (Exhibit 2), are not necessarily the ones with the most views. However, the web analytics data do not indicate the number of IP addresses that are represented by these views, nor whether these came from NES pilot teachers.

**Exhibit 3: Main Materials and Support Page Views**

Content Materials and Support Webpage	Page views, 2/26/10 – 6/25/10
Teaching Materials and Support – Main Page	2,306
Earth Climate Course	489
Rockets Guide	450
MY NASA DATA	436
Lunar Nautics	422
Black Hole Math	362
Smart Skies	345
Lunar Plant Growth	342
Cooling With Sunshades	237

Teacher reactions to individual products varied. Interview notes suggest that a few teachers chose not to implement specific modules because the materials seemed daunting or overwhelming and instead chose to select modules they perceived as easier. The organization and presentation of some modules may have affected teachers' perceptions and contributed to their selection. For example, a teacher in a focus group commented, "one thing that made the rocket launch so easy and appealing was the fact that it was so organized at the very beginning. There were sections that you could click on and it led you through. Whereas the *Black Hole Math* wasn't as clear to go through, so I chose the rocket one instead because I thought if I did the *Black Hole Math*, it would take more time to read through everything and

prepare.”<sup>13</sup> The interview notes also contained information about why some teachers had not implemented modules considered. Reasons cited for deciding to not implement modules included that the materials were too daunting, technology issues were encountered in getting online materials to run, and the timing of when a teacher became aware of the module.

In addition, teachers noted that they were less likely to use the modules where they did not appear to align with state and local standards and their existing curriculum. For example, one particular teacher noted that she selected a module because the topics covered were already part of her curriculum. If it had not already been part of the curriculum, she noted, that she may have had a harder time using it because of time constraints related to testing requirements. Moving forward, it might be useful to gather further information about why teachers made the decisions about which modules to use.

Data from the focus groups suggest that teachers felt that the materials fit the needs of high school and middle schools students. There was, however, variation in teachers’ perceptions of the appropriateness of the materials for students in the later elementary grades. Even in grades as high as sixth grade, some teachers found the language to be too advanced. However, there were examples of successful implementation in the elementary grades. For example, one focus group respondent commented, “I don’t think NASA realizes it but some of these curricula were just as successful in kindergarten and up to third grade as it is in fifth grade...”<sup>14</sup>

### ***Appropriateness and Modifications***

Teacher surveys indicated agreement among teachers that the modules were a good fit, easy to use, aligned well with what they taught, a good use of time, and provided ideas for engaging students (Exhibit 4). Teachers also reported that the materials were engaging and helped increase students’ interest. However, only 20 survey responses related to the curriculum modules were received, raising questions about whether the surveys were representative of the larger set of pilot teachers.

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<sup>13</sup> [Focus group report] Paragon-Tec. *NASA Explorer Schools: Qualitative and Quantitative Assessment of Redevelopment and Redesign Focus Group Analysis Final Report*. Report prepared for the NASA Explorer Schools Project. 2010, p.49.

<sup>14</sup> Focus group report, p. 42.

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**Exhibit 4: Curriculum Modules (N=20)**

Question	Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
This module was easy for me to use in my classroom.	19	1	0
This module was a good fit for my classroom.	18	1	1
This module aligns well with what I teach.	17	2	1
Using this module in my classroom was a good use of my instructional time.	19	1	0
This module provided ideas for encouraging student exploration, discussion, and participation.	19	1	0
My students found this product engaging.	20	0	0
This module is effective in increasing my students' interest in STEM topics.	18	1	1

Focus group notes indicated that teachers reported that the materials were generally appropriate but they often made minor adjustments to better integrate the modules into their classrooms. For example, one high school teacher found one module challenging, but modified its math portion and allowed students to work in teams. Interview data also indicate that some teachers made modifications to the NES materials. In some cases, teachers reported adapting the activities or modules to the specific circumstances of their situation. For example, one teacher revised the activities to fit within 42-minute classes. Another teacher modified the materials because not all of the required instruments were available. One teacher commented that the written material was too dense for his/her students so s/he rewrote portions of it. Other teachers created additional materials to facilitate implementation of the modules. For example, one teacher created Powerpoint slides to present the materials.

Teachers also discussed their desire to learn from each others' experiences with the materials. For example, as one focus group participant stated, "Maybe there can be a section within the curriculum where we can view the type of enhancements that some of us teachers have done to encourage the idea of extending knowledge and expanding activities. I think that's something they're missing out on a little bit."<sup>15</sup> If successful communities of practice were created within NES, they might provide a mechanism for teachers to learn from each others' experiences and share their materials and modifications with each other.

### **Timing**

Notes from the focus groups and interviews suggest the importance of timing in teachers' ability to integrate the materials into their classrooms. For example, one teacher identified a module that would have been appropriate for a fall class. The middle school teachers in the focus groups commented that had the timing of the pilot launch been earlier in the year they could have better incorporated the program into their classroom. High school teachers suggested that timing was a large part of why they were not able to use NES to its full potential; they too suggested implementing it at the beginning of the year. Although the timing was in part a function of the spring launch of the pilot, as the full project

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<sup>15</sup> Focus group report, p. 57.

implementation allows rolling enrollment, teachers who sign up for NES during the winter or spring may face similar issues.

### Virtual Breaking News (VBNs)

VBNs were developed for NES, instead of being selected from existing NASA resources. NES identified topics for the VBNs and spoke with the four Mission Directorates to identify upcoming events, research announcements, and milestones that would align with the selected topics. The VBN calendar was then built around specific events (e.g. Hubble Space Telescope 20<sup>th</sup> Anniversary, Earth Day) supplemented with non-date specific events. Decisions about the creation and timing of the events were made to ensure that topics were included from each of the Mission Directorates and that the events were offered on dates that spanned the NES pilot implementation period.

Although VBN is a key component of NES, not all teachers used these materials in their classrooms. As with the curriculum modules, there were fewer VBN surveys received (40) than NES pilot teachers (57). Among the teachers interviewed, 12 had not incorporated a VBN into their classroom, 13 had used one, 13 had used two VBNs, and 5 had used three or more.

Teacher surveys suggest that respondents applied the VBN events and that the materials aligned with the content they taught (Exhibit 5). The surveys also indicate that teachers agreed the VBNs “experience provided ideas for encouraging student exploration discussion and participation” (92.5%). The teacher surveys also suggest that the VBNs increased student interest in STEM and STEM careers (72.5%).

However, teacher interview notes indicate that not all segments were engaging. Further, the focus group report suggested that teachers did not find VBNs appropriate or engaging for their students. Interview notes from one teacher indicated that students thought the VBNs were boring. Similarly, focus group attendees did not feel that the VBN content was useful or engaging for students (71%) or relevant to their classroom (57%), and that the duration of VBN segments was inappropriate and should be shortened (71%), although the opportunity to receive live feedback during a VBN received a positive reaction from students.<sup>16</sup> Comments from the focus groups suggested that NES should “keep presentations fast-paced and use more props or visual aids” and that it might “keep in mind that kids are used to a lot of flash and pizzazz. Seeing someone just talking is not engaging for them.”

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<sup>16</sup> Focus group report, p.24

### Exhibit 5: Virtual Breaking News (N = 40)

Question	Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
I can immediately apply what I learned from this NASA experience to my teaching about science, technology, engineering or mathematics (STEM).	87.5%	7.5%	5.0%
The NASA materials used in this classroom media resource aligns well with what I teach.	82.5%	7.5%	10.0%
This classroom media resource was effective in increasing my students' interest in STEM topics.	80.0%	17.5%	2.5%
This classroom media resource was effective in increasing my students' interest in STEM careers.	72.5%	25.0%	2.5%
This NASA experience provided ideas for encouraging student exploration discussion and participation.	92.5%	2.5%	5.0%

Web analytics data documented the number times individual VBNs were viewed and played or downloaded. The data reveal great variation in the use of the VBNs. Furthermore, the pages that were viewed most frequently did not correspond with the VBNs that were downloaded the most (Exhibit 6).

### Exhibit 6: VBN Web Views and Downloads, Feb. 26, 2010 to June 25, 2010

Virtual Breaking News	Page Views	Page View Ranking	Air Date	Play/Download	Play Ranking
Solar Dynamics Observatory	469	3	3/18/2010	186	1
STS-132	408	6	5/12/2010	137	2
Microgravity Research	504	2	3/25/2010	132	3
STS-131	437	5	4/7/2010	127	4
Hubble's 20th Anniversary	450	4	4/1/2010	106	5
Flight Testing	326	8	4/29/2010	99	6
International Space Station	396	7	4/14/2010	59	7
Students Talk With the ISS	177	11	5/26/2010	59	8
Earth Day 2010	616	1	4/22/2010	46	9
Flight Suit Design	267	10	5/19/2010	36	10
NASA Missions to the Asteroids	173	12	6/2/2010	29	11
Earth Science Field Campaign	292	9	5/5/2010	27	12
NASA Careers Beyond Astronauts	108	13	6/9/2010	11	13

### Technical Issues

Teachers described some technical issues with the VBNs during the focus groups. These issues included problems with sound quality, the delay in getting feedback during live event chats, and local ability to stream live video.

## Teacher Support

NES provided teacher support through a variety of mechanisms, including initial support for the use of materials in the classroom via ePD videos, social networking opportunities, and website support.

### Electronic Professional Development (ePD)

Page view and download data from the web analytics show that ePD was accessed, although earlier clips for each ePD module were played or downloaded more often than later clips (Exhibit 7).

**Exhibit 7: Plays or Downloads by Content Module and Individual Clips**

Module	Play/Download	Clip						
	Total	One	Two	Three	Four	Five	Six	Seven
Earth Climate Course	270	84	64	52	36	34	--	--
Lunar Plant Growth	219	74	43	54	27	21	--	--
Lunar Nautics	275	66	47	46	30	41	45	--
Smart Skies	140	40	27	22	11	11	13	16
Rockets	267	73	48	40	44	39	23	--
MY NASA DATA	189	56	34	33	24	20	22	--
Cooling With Sunshades	56	17	10	14	8	7	--	--
Black Hole Math	164	64	30	24	14	14	17	--

Teacher surveys and focus group notes showed that teachers reported that the ePD facilitated classroom use of the modules. Teachers strongly agreed or agreed that after the ePDs they were confident in using the modules (89.8%) and more effective in teaching related STEM concepts (89.8%). The large majority (83.1%) agreed that the ePD provided the sufficient support necessary for classroom use of the module (Exhibit 8).

## Exhibit 8: Electronic Professional Development (N=59)

Question	Strongly Agree or Agree	Neutral	Strongly Disagree or Disagree
After participating in this ePD activity, I feel confident in using the associated NASA content module in my classroom.	89.8%	5.1%	0.0%
After participating in this ePD activity, I will be more effective in teaching STEM concepts introduced in this associated NASA content module.	89.8%	5.1%	0.0%
I can immediately apply what I learned from this ePD to my teaching about science, technology, engineering and math (STEM).	84.8%	8.5%	1.7%
This ePD activity has helped me to understand how I can use the associated content module in my classroom.	86.4%	6.8%	1.7%
After participating in this ePD activity, I am more likely to use the associated content module in my classroom than had I not participated in the ePD.	88.1%	5.1%	1.7%
This ePD activity was sufficient support to allow me to use the associated content module in my classroom.	83.1%	6.8%	5.1%
Note: Percents may not equal 100 due to rounding.			

Focus group comments supported with the sentiments conveyed through the surveys. Notably, all seven focus groups (each composed of four teachers) that discussed the ePDs felt that the ePD supported implementation of NES materials in the classroom. Some teachers found it useful and thought that the level of detail helpful. However, some teachers felt that the level of detail was too much. For example, one focus group participant commented, “Maybe too much knowledge at times. Wish it could be more of an overview instead of so many details. Need to make sure they are short and concise.”<sup>17</sup>

Teacher comments in the interviews and focus group notes also indicated that some teachers used the ePDs in their classrooms. In the interviews, five teachers mentioned that they showed portions of the videos to their students. Focus group participants’ comments also revealed that the ePD videos were used in the classroom. For example, one participant commented, “We liked how the videos explained the content. We also liked how the videos showed the content modules being used in the classroom. It gave us an idea on how to implement the product. We also used the short video clips in the classroom and it helped the students understand a little more.”<sup>18</sup>

### *Delivery mechanism*

There were three types of ePD: live, archived, and facilitated. Live segments were the live broadcast of an ePD taping. The recordings were then placed on the ePD website as archived or on-demand ePD. Facilitated ePDs consisted of a webinar format where a facilitator walked participants through materials and interacted with participants. In the interviews, one teacher mentioned having participated in the facilitated ePD, and noted that s/he preferred this format to the archived ePD, as the respondent

<sup>17</sup> Focus group report, p.81.

<sup>18</sup> Focus group report, p.81.

especially appreciated the opportunity to ask questions. This teacher also found the archived ePD helpful as well.

Both the focus group and interview notes indicate that teachers preferred the archived ePD format over the live ePD as it enabled more user control. One focus group teacher explained, “We liked the archived format of ePD because of our time constraints and different time zone issues. Live does not work for everyone.”<sup>19</sup> Another teacher further clarified the preference, “We preferred the archived format because it allowed us to go at our own pace, being able to pause or go back over sections. The live session times were not always during times that were doable, whether it be during school or after school activities. Ninety minutes seemed a little long.”<sup>20</sup>

Notes from the teachers interviews and the focus groups also indicated that archived ePD was considered the most accessible; the live ePD was less accessible, either because it required additional clicks or because they were not aware of the timing of the events: “The archived [ePD] was easier to locate because it was with the product page. The live version was under the scheduled event page and some people were not aware of that.”<sup>21</sup> Notes from one interview indicated that logging in for the live events was a challenge, but that archived events presented no such difficulties.

### Social Networking Tool

NES seeks to create opportunities for teachers to share their experiences and to create communities of practice. During the pilot program, the teachers’ blog was the only implemented social networking tool, and teacher interview notes revealed that the blog was not consistently used. Many teachers reported reading it occasionally; however most interviewed teachers noted the lack of interaction and comments on the blog. For example, one teacher reported that she would have liked to see more teacher participation, perhaps with questions at the end of the blog post to prompt teacher responses.

Teachers in the focus group voiced conflicting opinions about expanding the social networking component to Twitter and Facebook. The pilot website did contain a link to the NASA Twitter feed and one participant commented, “Facebook and Twitter should be taken off the site. Most educators cannot access social networking sites from school. Keep this a professional site, not for social networking”<sup>22</sup> However another teacher stated, “The use of Facebook and Twitter would be good; have a NES FB group and a NES Twitter feed. Have links to or provide Smartphone applications, such as a *Solar Dynamics Observatory* NASA application and other NES content applications for students and teachers to access via personal electronic devices.”<sup>23</sup>

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<sup>19</sup> Focus group report, p.82.

<sup>20</sup> Focus group, p.82.

<sup>21</sup> Focus group report, p.83.

<sup>22</sup> Focus group report, p.97

<sup>23</sup> Focus group report, p. 97.

## Website

Web analytics data indicate that the NES home page was viewed close to six thousand times during the pilot period (Exhibit 9). A general description of NES was not available on the home page, but instead on the *About* or *Frequently Asked Questions*. After the home page, the *Teaching Materials and Support Page* (2,306 views) and *Event Schedule* (1,429 views) received the most traffic.

**Exhibit 9: Page Views of Key NES Pilot Web Pages, Feb 26, 2010 to June 25, 2010**

Page	
NES Home Page	5,988
About	265
Teaching Materials and Support Main Page	2,306
Frequently Asked Questions	293
Event Schedule	1,429
Contact	128
<b>TOTAL:</b>	<b>10,409</b>

Page view data from the web analytics indicate that web portal usage remained steady throughout the pilot period, but dropped off in mid-May (Exhibit 10), coinciding with the end of the school year.

**Exhibit 10: Web Analytics Usage over Time**

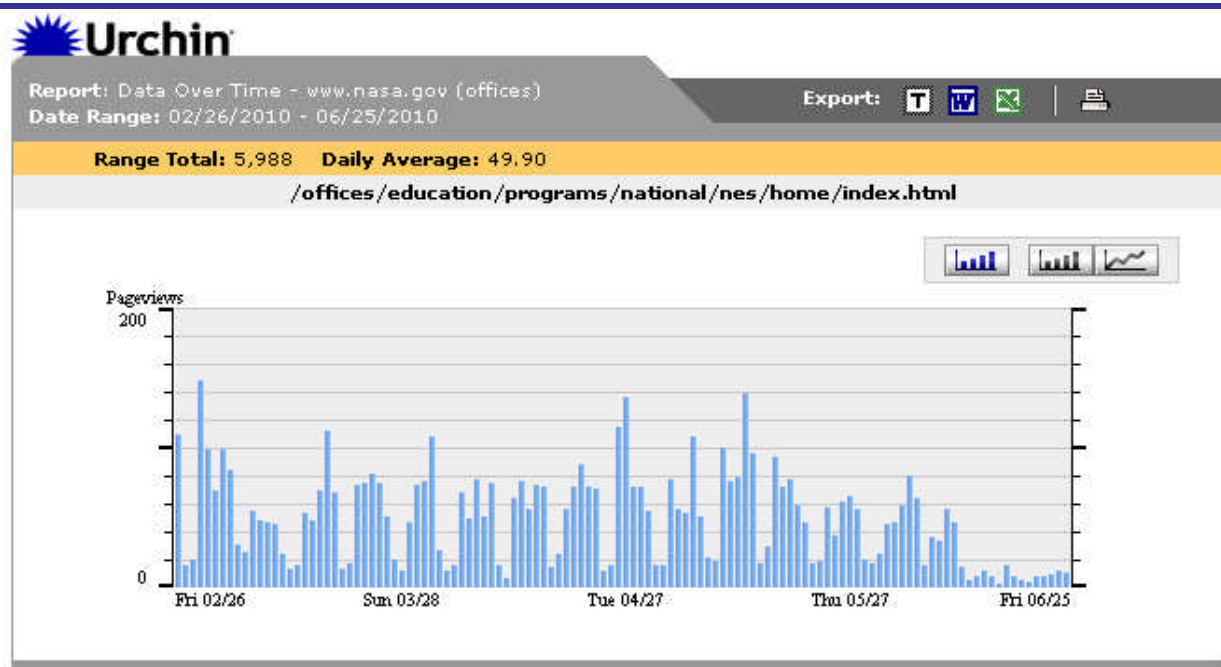


Figure taken from nes-pilot-metrics.xlsx

Among the interviewed teachers, notes show that most found the website interface user friendly. Thirty-seven of the 44 interview respondents found the website easy to navigate, although four of these had specific suggestions for improvement. For example, one teacher had trouble viewing the events page, and another noted there were too many clicks required to get to a desired page. Three teachers noted that it took them a while to familiarize themselves with the website and understand it, while only one teacher found it altogether challenging.

Teacher surveys and notes from the interviews and focus groups revealed that some IT issues occurred during the pilot period. The majority of reported issues revolved around downloading or viewing videos. Focus group participants noted that video buffering time was particularly long. Most of these issues occurred on the school or teacher end, while website operations on the NES seemed to run smoothly. NES staff report, however, reported that they were not alerted to these issues when they occurred and so could not offer assistance to resolve them.

### **Project Communication with Teachers**

Notes from teacher focus groups suggested that a variety of avenues for communication and support should be available, although most teachers seemed to agree that “email was very efficient and preferred.”<sup>24</sup>

The speed with which support was given seemed to be as important as the mode of communication. One educator suggested that NES keep in mind that “email support should occur within 24 hours. Phone or chat support should be available during all normal working hours and different time zones should be considered; have support hours on different days of the week to cover all U.S. time zones.”<sup>25</sup> Overwhelmingly, teachers in the focus group were satisfied with NES project communications during the pilot period, and educators involved in the focus groups noted how quickly the NASA staff got back to them. During the pilot period, a single staff member served as the primary point of contact. While teachers were very satisfied with the personal contact and communication during the pilot, for full implementation the NES project recognizes it would not be feasible for a single staff member to handle all contact and support.

## **Student Outcomes**

Data on student outcomes targeted by the NES project were collected from teachers via surveys, interviews, and focus groups, and from students using pre- and post-program surveys. Specifically, information was gathered on student engagement with the materials, student self-efficacy, and student interest in STEM topics, STEM careers, and NASA. The teachers provided information about their perceptions of student engagement with the NES materials, and interest in STEM and NASA careers. Students were asked about their interest in STEM and NASA content and careers, and their responses prior to and after NES implementation were compared to detect changes.

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<sup>24</sup> Focus group report. p.93.

<sup>25</sup> Focus group report, p. 94.

## Student Engagement with the NES Materials

Data from teacher surveys, interviews and the focus groups all indicate that overall students found the curricular materials engaging. All teachers who completed the survey on the curriculum modules strongly agreed or agreed that their students found the products engaging. Middle school and high school educators in the focus groups reported that their students were engaged with the curricular materials. While there was data from teachers that explored student engagement with the NES materials, student surveys did not ask students about their engagement with the NES materials. For the formative evaluation, it may be useful to consider survey or interview items that gather information directly from students about their levels of student engagement with the NES material.

## Self-Efficacy

The student surveys gathered information about students' perceptions of how good they were in science, technology, engineering, and mathematics (Exhibit 11). Comparing pre- to post-NES student self-efficacy, results were mixed; a significant positive difference was detected in self-efficacy in engineering, while a significant, negative difference was observed in self-efficacy in mathematics.

**Exhibit 11: Student Self Efficacy in STEM**

Question		Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
I am good at science	Pre NES	54.7%	29.9%	15.4%
	Post NES	53.0%	30.2%	16.8%
	Change	-1.7	0.3	1.4
I am good at technology	Pre NES	55.5%	28.3%	16.2%
	Post NES	58.5%	26.4%	15.1%
	Change	2.9	-1.8	-1.1
I am good at engineering*	Pre NES	30.4%	29.9%	39.8%
	Post NES	34.1%	31.5%	34.4%
	Change	3.7	1.6	-5.3
I am good at mathematics*	Pre NES	61.3%	23.9%	14.8%
	Post NES	57.6%	24.2%	18.2%
	Change	-3.7	0.3	3.4

\*p<.05, \*\*p<.01, \*\*\*p<.001

Numbers may differ slightly due to rounding.

## Interest in STEM

Teachers who completed the surveys felt that NES experiences increased student interest in STEM (Exhibit 12). In terms of the content modules, 90% of survey respondents strongly agreed or agreed that the modules increased student interest in STEM; 80% of teachers strongly agreed or agreed that the VBN was effective in increasing student interest in STEM, while just slightly fewer (72.5%) of teachers strongly agreed or agreed the VBN was effective in increasing student interest in STEM careers.

### Exhibit 12: Teacher Perceptions of Student Interest

Question	Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
<b>Content module (N=20)</b>			
My students found this product engaging.	100%	0	0
This module is effective in increasing my students' interest in STEM topics.	90.0%	5.0%	5.0%
<b>VBN (N=40)</b>			
This classroom media resource was effective in increasing my students' interest in STEM topics.	80.0%	17.5%	2.5%
This classroom media resource was effective in increasing my students' interest in STEM careers.	72.5%	25.0%	2.5%

Data from student surveys, however, showed no significant differences in students' pre- to post-NES interest in STEM (Exhibit 13).

### Exhibit 13: Student Interest in STEM Pre-NES and Post-NES

		Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
I am interested in science.	Pre NES	57.4%	27.2%	15.4%
	Post NES	55%	27.1%	17.9%
	Change	-2.4	-0.1	2.5
I am interested in technology.	Pre NES	69.7%	19.9%	10.4%
	Post NES	66.9%	21.4%	11.7%
	Change	-2.8	1.5	1.3
I am interested in engineering.	Pre NES	41.2%	26.5%	32.3%
	Post NES	40.6%	28.2%	31.2%
	Change	-0.6	1.7	-1.1
I am interested in mathematics.	Pre NES	52.1%	23.4%	24.4%
	Post NES	48.4%	25.7%	25.9%
	Change	-3.7	2.3	1.5

\*p<.05, \*\*p<.01, \*\*\*p<.001

### Interest in STEM Careers

Student surveys do not show a significant difference in interest in engineering and math careers following NES experiences. However, there was a significant positive difference in interest in science and technology careers after NES experiences (Exhibit 14).

#### Exhibit 14: Student Interest in Careers in STEM Fields

Question		Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
I am interested in careers in science.*	Pre NES	39.0%	28.9%	32.1%
	Post NES	42.6%	28.6%	28.8%
	Change	3.6	-0.3	-3.3
I am interested in careers in technology.**	Pre NES	46.0%	29.4%	24.7%
	Post NES	50.4%	26.8%	22.9%
	Change	4.4	-2.6	-1.8
I am interested in careers in engineering.	Pre NES	34.4%	24.3%	41.3%
	Post NES	36.4%	26.6%	37.0%
	Change	2.0	2.3	-4.3
I am interested in careers in math.	Pre NES	36.7%	26.8%	36.5%
	Post NES	39.1%	25.6%	35.3%
	Change	2.4	-1.2	-1.2

\*p<.05, \*\*p<.01, \*\*\*p<.001

Numbers may differ slightly due to rounding.

#### NASA-Specific Outcomes

Notes from teacher interviews and the findings from the focus groups suggested that the association with NASA held particular sway with parents and students. One teacher in a focus group noted, “This program has really made a difference in our children. Even just the word NASA gets them so excited.”<sup>26</sup> Another commented, “During parent conferences, I had three or four parents ask me what their children were viewing on NASA TV because their children had asked them if they could change their cable TV provider because they wanted NASA TV. I know of three families that actually changed their cable provider.”<sup>27</sup>

Data gathered directly from students via surveys, however, showed conflicting evidence of interest in NASA following NES experiences. Student surveys showed significant differences in interest in NASA and NASA following NES experiences, however, general interest in NASA declined while interest in NASA careers increased (Exhibit 15).

<sup>26</sup> Focus group report, p. 40.

<sup>27</sup> Focus group report, p.38.

### Exhibit 15: Student Survey Responses to Statements about NASA

		Strongly Agree and Agree	Neutral	Strongly Disagree and Disagree
I am interested in NASA.*	Pre NES	50.5%	32.9%	16.6%
	Post NES	46.5%	33.0%	20.5%
	Change	-4.0	0.1	3.9
I am interested in careers at NASA.*	Pre NES	28.8%	33.5%	37.7%
	Post NES	33.3%	31.4%	35.4%
	Change	4.5	-2.1	-2.3
I know a lot about NASA.***	Pre NES	16.9%	33.1%	50.0%
	Post NES	24.8%	34.5%	40.8%
	Change	7.9	1.4	-9.2

\*p<.05, \*\*p<.01, \*\*\*p<.001

The student survey also presented students with a list of 20 NASA activities and asked students to select all that they would be interested in pursuing. A comparison of the average number of activities selected on pre- surveys with the average number selected on post- surveys showed there was no significant difference between the number of NASA activities students were interested in pursuing before and after NES experiences (Exhibit 16).

### Exhibit 16: Student Interest in NASA Activities

Survey	Mean	Std. Deviation
PRE	6.53	4.81
POST	6.32	4.99

## Project Operations

### Teacher Recruitment

The pilot originally set a recruiting goal of at least 30 teachers. The pilot exceeded this goal by 27 teachers, mainly identified through its strategic partnerships. Among the teachers recruited, 25 had prior experience with NASA, which project staff credits with facilitating implementation. While the majority of recruitment was done through the strategic partners, not all planned partners contributed. At least one of the original partners did not successfully recruit teachers, and the partnership has not been pursued for the full project implementation. One group of particularly successful partnerships was with the U.S. Department of Education's Math and Science Partnerships program in three states, Georgia, Louisiana and Texas. This avenue for recruitment was highly successful and is being expanded in the full program as well.

The teacher focus group data suggests that teachers were interested in introducing NES to their colleagues, but they were looking for support from NES. For example, one focus group member noted, "I

would like to have a comprehensive welcome packet (email) that I can share with other teachers to get them started.”<sup>28</sup>

### Data Collection during Pilot

Data collected during the pilot served as a useful resource for making decisions about project refinements. The lessons from the pilot were summarized in the *NASA Explorer Schools Pilot Lessons Learned* presentation given at NASA Headquarters in August 2010. This presentation highlighted 229 specific observations derived from the pilot experiences, and proposed 192 corresponding corrective actions. NES has acted on many of these suggestions, incorporating changes into the project prior to launch, and is currently working on others.

Overall, staff interviews indicate that there was sufficient data collected to inform decisions related to the full project year one implementation. Nonetheless, obstacles in data collection were confronted. Notably, decisions about data collection were heavily influenced by government regulations—including restrictions on tracking individual web usage using IP addresses and the time required to undergo OMB review.

In addition, the teacher survey data and web analytics were intended to provide “real-time” feedback on the program. However due to logistical and software issues, teacher survey data took over a week to aggregate and be viewable to staff. Staff did not end up looking at the data until midway through the pilot at which point realized they were not getting many responses. Similarly web analytics were not viewed until the end of the pilot period.

Also, in most instances, the data gathered could not be linked to individual respondents. While this protected respondents’ identities, it did not allow the project to track teachers’ use the NES material. Some of these challenges may be mitigated to some extent by the teacher profiles in use during the full project implementation because these profiles allow for documentation of individual teacher access to, and use of, project components. Given that the NES project is structured so that teachers self-select into the program, and that they also dictate the extent to which they participate, program dosage will vary across teachers. The extent to which participation varies will provide insight into project implementation and will be important when looking at outcomes.

According to project staff, all key processes—including development of VBN, development of ePD, the curriculum selection process, the blog, other support, and some of the recruitment procedures—were documented and recorded in Powerpoint presentations. This documentation has allowed them to estimate resource and time requirements as they move into the full project implementation. Partners were responsible for many types of data reporting and concrete deliverables and came through with required products. However, due to the quick timeline for formulation and implementation of the pilot, some products did not receive the level of attention staff would have liked.

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<sup>28</sup> Focus group report, p. 105.

## Communication among Partners and Key Stakeholders

Interviews with NES staff suggest that there was sufficient communication between NES and partners, although the level varied across partners. According to NES staff, there were four formal meetings which included NES staff and strategic partners conducted between November 2009 and the end of the pilot period in June of 2010. In addition, key project staff frequently communicated with partners through informal channels (emails, calls, etc) throughout the pilot period.

Communications among key implementing partners were generally consistent and considered satisfactory throughout the implementation period. However, one staff member suggested that communications with some implementing partners could have been more frequent.

Interviews with staff suggest that communication with internal NASA partners was adequate, and NASA Mission Directorates and Office of Education were called upon as needed. NES stakeholders within NASA—including individuals at NASA’s Office of Education, the Manager of Elementary and Secondary Education, the Assistant Administrator and Deputy Assistant Administrator for Education, and the Education Coordinating Committee—were briefed at key points. The Assistant Administrator and Deputy Assistant Administrator for Education were briefed at the outset of every major phase of the program, and the Education Coordinating Committee was briefed four times throughout the pilot through the appropriate channels of communication.

Groups and individuals external to NASA that share a common interest in STEM initiatives are also stakeholders in NES and served as valuable resources during the pilot. NES contacted many organizations to advertise and promote the NES program. NES approached several external stakeholders to become strategic partners and formed this relationship with NSTA, ICLE and ITEEA. NES attempted to partner with the Department of Education, as was redirected to participants in the Department of Education’s Math and Science Partnership program. This body then partnered with NES for recruitment purposes. During a national conference attended by many external stakeholders, NES was given an award from the Center for Excellence in Education; this event created a strategic opportunity to promote the program.

## NES Response to Lessons from Pilot

NES made numerous modifications as a result of the lessons learned and recommendations that arose from NASA and partner staff members’ analyses of the pilot data and observations during the pilot implementation. There were numerous recommendations detailed in the *NASA Explorer Schools Pilot Lessons Learned* presentation and a large majority of these were implemented. In this section, we highlight some specific examples of how the NES project has responded to the lessons from the pilot project.

## Curriculum Selection Plan

The selection team initially vetted hundreds of NASA educational products developed by the various Mission Directorates, reducing the number to 31 for the external review process. The curriculum selection process for the pilot was formulated and implemented in a single month. After reviewing the process, NES staffers concluded that quality products may have been overlooked in the haste of the pilot selection process. Therefore, for year one implementation, a revised curriculum selection process was enacted and headed by partners at OSU.

## Videos for Classroom Use

An unexpected observation from the pilot was that teachers were using clips from the ePD segments in their classrooms to either engage students, demonstrate activities, or present information in the modules. NES took note and has prepared video segments that are meant to be used in the classroom.

## VCN

NES responded to feedback from teachers suggesting that VCNs could be more engaging. In particular, students are accustomed to video productions (e.g. television shows and movies) that are highly polished and fast paced. The VCN segments have been reworked and rebranded as “NASA Now!” which features an engaging host, fast-paced content, as well as many visual aids and special effects.

## ePD

For year one implementation, NES is continuing to offer the archived and facilitated ePD formats. Due to participant feedback from the pilot indicating that the live sessions were difficult to attend, they have removed this format. However, on the virtual campus the facilitated ePD is being relabeled as “live ePD”.

## Curriculum Use

NES has included identifiers and links to assist teachers in selecting appropriate modules for their classrooms. On each curriculum module homepage, NES has identified the: subject(s) covered, topic(s) covered, classification of activity type, targeted grade level, instructional objective, estimated time required to complete the activity, a list of materials needed, and alignment to national content standards. In addition, for lengthy modules, NES has selected featured lessons within these products.

## Recruitment

NES had great success in recruitment during the pilot through its strategic partners and is accordingly expanding the reach of these partnerships. For example, because of the success experienced during the pilot, NES is working to expand its partnering relationships with the Math and Science Partnerships program to include 4 additional states (Florida, Alabama, Tennessee and New Jersey); in addition, contact has been made with two additional states (Michigan and Illinois).

## Alignment to State Standards

Because NES is a national program, the alignment of materials to the national standards was a consideration in the selection of curriculum materials. The pilot revealed that teachers are concerned with the alignment to individual state standards, which teachers are responsible for following. Comparing NES materials to all state standards is a daunting task for the NES project to undertake alongside full implementation. To address this need, NES is leveraging its partnerships with state MSP offices, which are familiar with the local standards.

## Participant Support

During the pilot, a single staff member provided the bulk of the teacher support, answering emails and calls from participants. Given this experience, it was clear that for full implementation more than one staff member would be needed to provide support. Therefore, for year one implementation this process has been staffed up. NES created a phone number and email address dedicated to participant support. Several staff members are responsible for covering phones lines during business hours and responding to email.

# Conclusions

Abt's review of the data from the NES pilot was structured to answer eight research questions related to NES classroom materials, teacher support, student outcomes, and project operations. Abt examined the data available from the pilot NES project implementation, including student surveys, teacher surveys, notes from interviews with teachers, a summary report of teacher focus groups, and web use data. These sources of data were supplemented by reviews of project materials and interviews with NES staff. Below we use information from the pilot to answer the research questions, and then present some additional recommendations for consideration. Finally, we discuss some important recommendations related to the evaluation of NES.

## Research Questions

### Classroom Materials

#### ***Were the materials selected from among highly-rated NASA educational products?***

Pilot data document the use of a systematic process to select the NES curricular materials. The selection process resulted in the identification of four middle school and four high school curriculum products that were each within the top ten rated products from among all NASA-developed curriculum products. While the time constraints of the pilot imposed some limitations on the process, the materials appear to represent high-quality products as rated by reviewers and were well-received by most teachers. Further, the full implementation of NES incorporated lessons from the pilot process in selecting additional products.

In contrast, instead of selecting the VBNs from among existing resources, VBNs were created specifically for NES. Decisions were made to ensure that the VBNs included topics from across the Mission Directorates and were offered throughout the NES implementation period. Teacher reactions suggest that the production quality was not what teachers expected, nor what students were accustomed to in video products. For the full implementation, NES has revised the VBNs to address this issue.

***Were the NES materials appropriate for the targeted student audiences?***

Overall, the data collected provides evidence that NES curriculum products were appropriate for students. There were some challenges encountered in the early grades, as some teachers perceived the curriculum products to be too advanced for the youngest grades that implemented NES. In the higher grades, teachers reported difficulties in integrating the materials into the curriculum mainly because of the timing of the program, or because it was unclear to them how the products aligned with state standards.

While survey responses reflected positively on the VBNs, teacher focus groups and interviews suggest that the VBNs did not engage students. Specific recommendations about length and energy level were given and NES has made modifications to the VBNs.

## **Teacher Support**

***Were teachers able to implement the NES materials with the support provided?***

Based on the data gathered during teacher interviews, focus groups, and surveys, it appears that NES provided sufficient support to implement the materials. Over 89 percent of survey respondents agreed that after participating in the ePD activity they were confident in using the associated NASA module in their classrooms, and over 86 percent agreed that the ePD helped them understand the content of the NASA modules.

***Were specific forms of support preferred by teachers?***

Teachers expressed a preference for the archived training of ePD, both through their actions and their words. Teachers accessed and viewed the archived ePDs more frequently than the live events, and in the focus groups and interviews, they indicated that the archived ePDs were preferred, in part because the live events were not always held at convenient times and the archived events let teachers choose the pace of instruction. Only one facilitated event was held, and only one teacher participated; this teacher preferred the facilitated format to the archived and enjoyed the opportunity to pose questions.

***Are communities of practice being established around NES?***

Teachers serve as a potentially valuable source of support in the implementation of NES. As such, NES lists developing teacher communities of practice among its long-term goals. We expect that it will take time for networks to develop around NES, and the pilot period was insufficient for these relationships appear. Therefore, we did not expect to see established communities. However, we looked for evidence that teachers were engaging with each other, which might serve as indicators that the conditions for communities of practice were being established. We found less evidence that teachers were making connections related to their use of NES, although they would like to learn from each others' experiences. The blog, which was a primary mechanism for beginning to establish connections,

appeared among the least used resources during the pilot. The NES staff is currently making changes in the full implementation to create environments that can nurture teacher communication and the development of networks.

***Did teachers encounter issues in using the NES materials? If so, did NES address these issues?***

Pilot teachers were generally satisfied with the communications that they received from NES. Teachers reported some IT issues, the majority of which revolved around downloading and viewing videos. These issues typically occurred on the school or teacher end, while website operations on the NES seemed to run smoothly. In many instances, NES teachers did not approach NES with the issues they encountered, so NES staff members were not given the opportunity to help resolve the issues.

## **Student Outcomes**

***Were the NES materials engaging for students?***

Teachers reported that students were excited by the NES curricular materials and engaged in the activities. They reported that students were less engaged with the VBNs, either because of the length of the videos or because the presentations were not sufficiently exciting. The pilot did not collect information from students to measure their levels of engagement with the NES materials.

***Did students express increased interest in STEM topics and careers after participating in NES?***

Results on student outcomes were mixed. While the teachers surveyed reported that NES experiences increased student interest in STEM, student surveys that measured pre- and post-program levels of interest did not consistently reflect positive increases. There were no pre- to post-NES differences in student interest in STEM topics, however, there was a significant positive difference in interest in science and technology careers after NES experiences. Also, although teachers noted that the NASA affiliation was particularly appealing to students and student surveys showed a significant increase in interest in NASA careers following NES experiences, general interest in NASA declined.

## **Recommendations**

As noted earlier, the experiences from NES have already been used for project improvement. Below we present a few recommendations for the project to consider as it further refines its implementation.

### **Social Networking**

High school teachers specifically requested a space or area where they could share best practices with each other—particularly to share ideas, changes, expansions, or additions to curriculum modules or adapting modules for specific classes. NES has created a Facebook fan page as well as a forum for NES participants on NASA Educators Online Network (NEON), and there is the Teachers Corner. However, these tools are not being widely promoted and are underutilized. With more advertisement and involvement from NES staff these tools have the potential to be a powerful mode of communication across and between participants. Also, once teachers log into their accounts, the links to these social networking tools no longer appear on the right side of the page and teachers must click back to find the

links. This need to click multiple links to get to a resource was one of the drawbacks that pilot teachers identified in the website.

In the pilot evaluation it was suggested that NES create a Twitter feed to provide updates and answer student questions as they related to the VBN.<sup>29</sup> NES responded by creating a Twitter feed. However, there is not an obvious link to the NES twitter feed from the virtual campus. Confusingly, it does provide a link to the general NASA twitter feed, but this does not contain any information about the NES program. Again with more promotion and staff involvement this mechanism could be informative and engaging for participants.

Further, teacher experiences and modifications are typically linked to specific VBNs or curriculum modules. Website space, directly linked to each product, where teachers can write their comments and upload additional materials for others to use is a potentially important resource for teachers. NES should monitor the use of the comments space to help determine whether this is serving its intended purpose.

### **Timing and Implementation**

The middle school teachers noted during the focus groups that had the timing of the pilot launch been earlier in the year, they could better have incorporated the program into their classroom. Some teachers suggested that the delayed start was a large part of why they were not able to use NES to its full potential. For example, the interview notes suggest that one teacher reported s/he had already taught the class where one of the modules would have fit. If NES continues to allow rolling enrollment throughout the academic year, this may continue to be an issue among teachers who enroll late in the year. The project might want to consider limiting its window of enrollment, or at a minimum, encourage teachers to revisit how they might integrate NES materials in their larger curriculum prior to start of the upcoming year.

### **State Standards**

Focus group feedback indicated that teachers are very concerned with state standards and aligning materials to state standards. NES has changed the presentation of curriculum modules on the virtual campus such that each module's content areas and national standards relating to those areas are included in the description. However, teachers are significantly more concerned with state standards. Teachers recommended that NES provide a table with the topics of the individual modules and how they align with state standards. Although NES may not have the resources to undertake the entire venture, its partnerships, particularly with MSP can begin to provide this information. It will be useful to create a central repository that documents the alignment of individual modules to state standards in those instances where individual teachers or organizations are identifying the alignment.

### **Modifications to Materials**

Because NES developed the VBNs, the project was able to modify these, based on feedback from the pilot, into the NASA Now events that are offered for the full NES implementation. In contrast, because

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<sup>29</sup> Focus group, p. 15.

the curriculum products were developed by NASA's Mission Directorates, NES does not have a mechanism to modify the products. As NES becomes more familiar with the NES modules' use in classrooms, what works and what does not, including what modifications teachers make and their suggestions for improvement, NES might consider how to incorporate this into the project or the materials. Currently, if a product does not work well in classrooms the main remedy that NES has is to remove it from its offerings. This is an extreme step and does not resolve situations where only refinements might be necessary. As NES matures, one area for project development and long-term planning might be to create a mechanism by which NES can modify products or work with the original developers to make changes to the products.

### **Teacher to Teacher Recruitment**

While the partnerships were successful in recruiting teachers for the pilot, the full implementation should build on these successes and empower teachers to participate in the recruitment. We recommend that NES create materials that teachers could share with other teachers who are interested in NES. Word of mouth is a potentially powerful recruitment tool that the project has not yet leveraged. NES could facilitate teachers' peer recruitment by making information about the project easily available, which teachers could distribute as they share their successes with the NES materials with other teachers. For example, an NES document or welcome kit could be available to be printed and used by teachers to share with their colleagues. These materials could be given to other teachers informally, at professional meetings, and conferences and serve as a recruitment tool, allowing NES to utilize the informal networks among teachers and help build the community of NES practitioners.

We also recommend that NES place a concise description of NES on its main web page. Currently, the NSTA webpage that directs teachers to the NES website contains a concise description of the NES project so that when teachers reach the NES website from NSTA, they would have seen an overview of the project. However, if a teacher goes directly to the NES main webpage, they would not see an overview of the project without clicking on the *About NES* link. Further, the second webpage from a Google search for "NASA Explorer Schools" directs users to a site explaining that the project is not currently accepting applications. Though the site does provide a link to the current NES website, this information could be confusing to someone who is not familiar with NES and has not followed the redesign process.

### **Wide Range of Developmental Levels**

By defining middle grades as fourth through eighth grades, NES attracts a wide range of developmental and ability levels, which creates unique challenges for the project. NES has created a snapshot for each curriculum product summarizing the subject(s) covered, topic(s) covered, classification of activity type, targeted grade level, instructional objective, estimated time required to complete the activity, a list of materials needed, and alignment to national content standards. However, some more specifics about the ability levels, including the reading levels of the materials, or modifications that have been used to make the materials appropriate for particular grades, would be useful to teachers. At a minimum, it would alert teachers of younger grades that they may need to reconsider whether the modules are appropriate in their classrooms.

## Specific Considerations for Evaluation

The implementation of NES is moving forward concurrently as the plans for evaluation continue. The next evaluation phase for NES is to conduct a formative evaluation during spring 2010 and to incorporate measures of teacher and student outcomes into the evaluation during the 2011-2012 academic year. The formative evaluation will investigate whether the project overall, and its individual components, is being implemented as planned—including the incorporated corrective actions that stemmed from the pilot. The formative component will also document additional lessons from the full NES implementation that might inform program improvement. The second stage of the evaluation will include an outcomes component that will investigate whether there is evidence that program participants are exhibiting the intended outcomes, including pre-post gains on outcomes of interest. Below we discuss some considerations specific to the evaluation drawn from the NES pilot experiences.

### Tracking Use of Materials

Interview notes suggest that not all teachers used the curricular materials or VBNs in their classrooms. For example, there were a couple of instances where the materials had not been used in the classroom even after a teacher had downloaded materials and completed the preparatory ePD. In addition, NES staff raised the concern that because NES is an interest-driven model, experiences across teachers may differ greatly. Thus, outcomes may be related to levels of implementation which are correlated with self-selection. As we consider project outcomes, attention should be paid to the individual components that are used and their levels of use to better understand the implementation and outcomes of NES in different scenarios. This is why, in addition to leveraging the survey data that NES collects specific to each component, the formative evaluation will use teacher logs to track actual use of materials in the classroom.

### Measuring Student Engagement

Measuring student outcomes is complicated by the fact that students experience NES within a larger classroom context. Their STEM-related outcomes will be influenced both by the NES project as well as other experiences they have had both within and outside the classroom. The formative evaluation will gather information directly from students about their experiences with NES to understand what their experiences and levels of engagement with the NES materials have been. During the 2011-2012 academic year, the evaluation will be designed to investigate whether there is evidence of changes in student interest in STEM, NASA STEM careers, and NASA.

### Investigating the Recognition Component

The NES model includes a recognition program that was not included in the pilot phase due to time constraints. The recognition program will acknowledge teachers, students, and schools who demonstrate best practices. As this component is instituted, the evaluation will need to document teacher, student, and schools' experiences with this component of the project, as well as determine the related outcomes of these experiences. Specifically, the evaluation will seek to disentangle whether the

recognition program is a lever for the intended outcomes, or simply recognition that the best practices are in place.

Finally, the pilot provided a strong foundation for the NES program as well as the NES evaluation. As we move forward with the NES evaluation, attention will be paid to the corrective actions that were taken in response to the lessons summarized in the *NASA Explorer Schools Pilot Lessons Learned* presentation.

## Appendix A. Lesson Learned Topics

The *NASA Explorer Schools: Pilot Lessons Learned* presentation identified specific conclusions and proposed corrective actions from the NES pilot experience, organized around the following topic areas:

- Project delivery
  - Blog
    - Encouraging reader dialogue
    - Comment review process
    - Web platform
  - Electronic Professional Development
    - Delivery format
    - Video segments
    - Alignment to external PD resources
  - Virtual Breaking News
    - Delivery segments
    - Classroom relevance
    - Intraproject connectivity
  - Virtual Campus (on 1<sup>st</sup> page called Portal maintenance)
    - Unclear updating plan
    - Availability of tools
    - Web page layout
  - Participant communication
    - Direct interaction
    - Poorly advertised project calendar
    - Building project champions
- Engagement
  - Strategic partners
    - Importance of funding
    - NASA Office of Education engagement
    - Clearly defined roles
  - Mission directorates
    - Varying levels of availability
    - Vital project resource
  - School recruitment
    - Recruitment of experienced NASA teachers
    - Engaging the Math and Science Partnerships Program
    - Timely and targeted recruitment pitches
  - Orientation and onboarding
    - Informal registration
    - Interactivity of the WebEx tool
    - Clear and concise information
  - Office of Education/Centers

- Involvement in key decision points
  - Political realities and priorities
  - Project planning and reporting
- Evaluation and assessment
  - Survey methodology
    - OMB approval
    - Defining project impact
    - Survey response data
  - Survey delivery
    - OEPM limitations
    - SCANTRON
    - Qualitative versus quantitative data
  - Portal analytics
    - Lag for “real time” data
    - Retrieving analytic data
    - Using analytics for project improvement
  - Content selection
    - Timeline constraints
    - Reviewer selection bias
    - Initial product screening bias
    - Effectiveness of selection methodology
- Project management
  - Project formulation
    - Value of external input
    - Arduous but effective process
  - Project alignment
    - Agency-wide alignment
    - Uniform NASA educational products
    - National STEM alignment
  - Project reporting
    - Use of NASA OE databases
    - Preemptive reporting
    - Briefing the agency
  - Securing workforce support
    - Conducting market research
    - Securing OE buy-in
    - Leveraging existing/internal resources

## Appendix B. Non-Response Bias Tests for Student Surveys

**Exhibit B1: Baseline Comparison of Included Students (School Post-Tests Available) Versus Excluded Students (No School Post-Tests)**

Statement	Respondents from schools that contributed pre and post surveys (Included)			Respondents from schools that contributed ONLY pre surveys (excluded)						
	Strongly Agree or Agree (%)	Neutral (%)	Strongly Disagree or Disagree (%)	Strongly Agree or Agree (%)	Neutral (%)	Strongly Disagree or Disagree (%)	df	N	$\chi^2$	p
I am interested in NASA.	50.5	32.9	16.6	58.5	29.5	12.0	4	3036	17.60	.002*
I am interested in science.	57.4	27.2	15.4	66.7	22.3	11.1	4	3032	23.79	<.0001*
I am interested in technology.	69.7	19.9	10.4	71.3	18.9	9.9	4	3005	0.78	.941
I am interested in engineering.	41.2	26.5	32.3	46.2	25.6	28.2	4	3011	8.35	.080
I am interested in mathematics.	52.1	23.4	24.4	58.6	22.1	19.3	4	2998	15.49	.004*
I know a lot about NASA.	16.9	33.1	50.0	26.9	32.1	41.0	4	2991	42.98	.002*
I am good at science.	54.7	29.9	15.4	63.4	27.4	9.2	4	3008	34.72	<.0001*
I am good at technology.	55.5	28.3	16.2	62.5	24.7	12.8	4	3000	12.86	.012*
I am good at engineering.	30.4	29.9	39.8	38.4	29.9	31.8	4	3004	21.00	.0003*
I am good at mathematics.	61.3	23.9	14.8	69.9	19.8	10.3	4	2994	30.66	<.0001*
I am interested in careers at NASA.	28.8	33.5	37.7	34.1	32.3	33.6	4	2984	8.33	.080
I am interested in careers in science.	39.0	28.9	32.1	43.6	29.6	26.8	4	2973	12.77	.013*
I am interested in careers in technology.	46.0	29.4	24.7	45.0	27.4	27.7	4	2968	6.51	.164
I am interested in careers in engineering.	34.4	24.3	41.3	38.4	24.1	37.5	4	2972	6.29	.179
I am interested in careers in mathematics.	36.7	26.8	36.5	40.7	26.7	32.6	4	2952	6.37	.173